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Chronologic Constraints on Secondary Alteration Processes. Ian D. Hutcheon, Isotope Sciences Division., Lawrence Livermore National Laboratory, Livermore, CA 94551; hutcheon1@llnl.gov

A central goal of meteoritics is understanding the chronology of events leading to the transformation (*a.k.a.*, modification) of interstellar precursor material inherited by the nascent solar nebula to form first meteorites and then small planetary bodies by processes of evaporation and condensation, melting and recrystallization, accretion, brecciation and metamorphism. Within the context of this workshop there is a particular need to distinguish to the extent possible, chronological differences between nebular and parent body processes related to specific features in chondritic meteorites. The most direct and readily interpreted information on the time scale of chondrite metamorphism comes from radiometric age dating of "secondary" minerals, i.e., phases produced as a result of metasomatic events in the solar nebula or on parent bodies. Carbonates in CI and CM chondrites and most Ca-phosphates and many feldspars in equilibrated ordinary chondrites are secondary minerals which have been used for this application [1, 2, 3]. Two short-lived radionuclide systems have provided strong evidence that metamorphic processes began less than 10 Ma after formation of the first solar system solids. Excesses of ^{53}Cr, from the decay of ^{53}Mn ($\tau_{1/2}$ = 3.7 Ma) in carbonates from Orgueil, indicate an early onset of aqueous activity on the CI planetesimal, only ~ 15 Ma after the formation of CAI [4, 5] This time scale is also commensurate with that inferred for the formation of Fe-Mn-phosphates in the IIIAB irons, presumably by (secondary) oxidation of phosphorus originally contained in metal [6]. Evidence of radiogenic ^{26}Mg in plagioclase from Ste. Marguerite [7] provides additional evidence for the rapid growth of chondrite parent bodies with cooling below the Al-Mg closure temperature within ~ 6 Ma of CAI formation. Data from the ^{129}I - ^{129}Xe and U - Pb systems are complementary, supporting the early onset scenario while also indicating that metamorphic activity on some chondrite parent bodies continued over a protracted interval of up to ~ 60 Ma [8, 9]. Unfortunately, while the range of metamorphic ages from both the I-Xe and U-Pb systems is very similar, most attempts to correlate I-Xe and Pb-Pb ages of individual meteorites have proved unsuccessful. An important exception is recent work demonstrating good agreement for phosphate mineral separates [10]. Most of the chronological data relating to the times of formation of secondary minerals in chondrites, excluding CAIs, indicate relatively long times and appear to "date" parent body processes, since times scales appear incommensurate with anticipated nebular lifetimes.

References: [1] Richardson, S.M. *Meteoritics* **13**, 141-159 (1978); [2] Van Schmus, W.R. and Wood, J.A. *CGA* **31**, 747-765 (1967); [3] Perron C., Bourot-Denise M., Marti K., Kim S., and Crozaz G. *Meteoritics* **27**, 275 (1988); [4] Endress, M., Zinner, E. and Bischoff, A. *Nature* **379**, 701-703 (1996); [5] Hutcheon, I.D. and Phinney, D.L. *Lunar Planet. Sci.* **27**, 577-578 (1996); [6] Hutcheon, I.D., Olsen, E.J., Zipfel, J. and Wasserburg, G.J. *Lunar Planet. Sci.* **23**, 565-566 (1992); [7] Zinner E.K. and Göpel C. *Meteoritics* **27**, 311-312 (1992); [8] Swindle T.D. and Podosek F.A. *Meteorites and the Early Solar System*, 1127-1145 (1988); [9] Göpel C., Manhes G. and Allegre C.J. *EPSL* **121**, 153-171 (1994); [10] Brazzle P.R. and Hohenburg C.M. *Meteoritics* **31**, A20-A21 (1996). Work performed under the auspices of the DOE by LLNL under Contract W-7405-Eng-48.